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ONTARIO

Department of Education

Courses of Study

Grades XI and XII

in

Collegiate Institutes, High

and

Continuation Schools

SCIENCE

AND

AGRICULTURAL SCIENCE

Issued by Authority of
The Minister of Education

COURSES OF STUDY

For

Grades XI and XII

in

Collegiate Institutes, High and Continuation Schools

SCIENCE

The Science of Grades XI and XII is an experimental study, and emphasis should be based on pupil experiments throughout the course. Accuracy and precision in making observations, taking measurements, and reaching conclusions are the main desiderata. Encouragement should be given to the recording of experiments by means of simple line diagrams, supplemented by very brief notes. Time should not be wasted in writing copious notes from dictation or in copying material from text or manual. The pupil should not be asked to report in full more than about half a dozen outstanding experiments.

PHYSICS, GRADE XI

OBLIGATORY COURSE

Density and specific gravity. (Ten periods.)

Review the meaning of the term density and show that density may be stated in various units, such as grams per cubic centimetre, grams per litre, pounds per cubic foot or cubic inch, pounds per gallon.
The meaning of the specific gravity (s.g.) of a substance.
An experiment to determine the density and the s.g. of a regular solid, e.g., a brass cylinder, by measurement of its dimensions, and by weighing. (Use of vernier calipers recommended but not required.)
Experiments, involving the application of Archimedes' Principle, to determine the s.g. (1) of the brass cylinder used above, (2) of an irregular solid, denser than water, (3) of a liquid.
An experiment to demonstrate the principle of flotation.
The hydrometer—an experiment, using the hydrometer, to determine the s.g. of brine or other liquid.

Force and motion. (Three periods.)

Experiments to illustrate the meaning of inertia and of force and to show that force can cause a change of velocity.
Newton's First Law of Motion. The definition of force in terms of the change in velocity produced in a body.
The meaning of momentum.

Sound. (Sixteen periods.)

Experiments to show that sound has its origin in a vibrating source.
Experiments to illustrate vibratory motion using (a) the simple pendulum and (b) a spring with a weight attached.
The meaning of amplitude, period, and frequency as applied to vibratory motion.
A discussion of the action of a restoring force (elasticity) in the vibration of the spring.

The characteristics of sounds:

(1) Intensity; its dependence on the amplitude of vibration and the distance from the source (qualitative treatment only).

(2) Pitch; a demonstration of pitch using the Savart toothed wheel or the siren. The difference between tone and noise.

(3) Quality or timbre; a demonstration of differences in quality using tuning-fork, sonometer, organ pipe, etc.

An experiment to show that a material medium is necessary for the propagation of sound.

A quantitative experiment to show that the frequency of a stretched string varies inversely as the length.
A qualitative experiment to show that the frequency depends on the tension.

A discussion of wave motion, emphasizing that it is the transmission of vibration from particle to particle.
The transmission of energy by waves.
The interrelation of velocity, wave length and frequency.
An experiment to illustrate the propagation of transverse waves in any medium, e.g., in a rope or rubber tubing.

An experiment to show the way in which a stretched string vibrates—as a whole and in segments.
A discussion of the effect of the superposition of waves on the quality of the sound produced. Illustrate with two or more tuning-forks of different frequencies sounded together, or with one tuning-fork (a) bowed, (b) struck with a hard object, (c) bowed and struck so as to produce fundamental and overtone at the same time.

An experiment to illustrate the propagation of longitudinal waves in any medium, e.g., a brass coil.

A brief discussion of the reflection of sound and some of its applications.

A discussion of the measurement of the speed of sound by means of echoes or by a direct method.

Light.
—Transmission.
(Four periods.)

An experiment to show that a material medium is not required.
Rectilinear propagation (review).
An experiment to show the production of a pinhole image and the change in size of this image with variation in the distance of the screen or of the source from the pinhole.
A discussion of the reason for the formation of the image.
Simple discussion of the velocity of light.

—Reflection.
(Five periods.)

Experiments with plane mirror to derive the laws of reflection of light. Regular and diffuse reflection; discussion of direct and indirect lighting.
An experiment, using a single plane mirror, to show the location of images and the path of the rays to the eye.

Demonstrations, using a concave mirror, of (a) the focusing of parallel rays and (b) the production of a real image.

—Refraction. (Six periods.)

A demonstration of the refraction of light using (a) air and water and (b) air and glass. Explanation by means of waves.
An experiment to trace the path of light through a glass plate with parallel sides.
An experiment to show deviation produced by refraction through a prism.

—Lenses. (Six periods.)

Experiments to show the effect of a converging glass lens on parallel rays. The meaning of principal focus. The path of a ray (1) parallel to the principal axis and (2) through the centre of the lens (comparison with a ray passing obliquely through a thin glass plate). The method of locating the image.
Real and virtual images. (The pupil should be taught that there is only one general construction, and no suggestion should be made of memorizing the nature and the position of images for various positions of the object. Emphasis should be laid on the complete cone of rays which falls on the lens from any point on the object and continues through the lens to the eye.)

—Dispersion. (Three periods.)

Experiments to demonstrate the spectrum of white light, and the combination of spectrum hues to form white light.
The meaning of infra-red and ultra-violet.

—Practical applications. (Three periods.)

The camera.
The human eye; the function of its parts in the production of an image; recall iris reflex; the action of the lens in focusing the image (accommodation); comparison with the camera. (Technical terms are not required.)

Heat.

Review previous study of heat.

—Heat transfer. (Five periods.)

An experiment to show the comparative heat conductivities of different solids.
Experiments to compare the radiation and absorption by dull dark, and light polished surfaces.

The expansion of solids. An experiment to show the unequal expansion of metals. The thermostat.

—Heat measurements. (Ten periods.)

Calorimeter experiments to determine (1) the specific heat of a metal, (2) the heat of fusion of ice.

PHYSICS, GRADE XII

OBLIGATORY COURSE

Electrostatics. (Five periods.)

Experiments to show the electrification of ebonite rubbed with fur (or flannel) and of glass rubbed with silk (or chamois impregnated with tin amalgam).
The charging of a pith ball by contact. Conductors and non-conductors.
An experiment using the pith ball as an electroscope to show attraction and repulsion. An experiment to show that there are two kinds of electrification.
The use of conventional terms—positive and negative—to classify electric charges.
The construction and use of the goldleaf electroscope.

Magnetic effect of an electric current. (Fourteen periods.)

A review of elementary magnetism with a discussion of the use of lines to picture a magnetic field.
An experiment to show magnetism induced in a para-magnetic substance placed near a bar magnet.
A discussion of the difference between a temporary and a permanent magnet.

Experiments to show (1) the lines of force about a wire carrying a current and the reversal of the magnetic field with a change in the direction of the current, (2) the magnetic field due to a current in a single turn of wire, (3) the magnetic field due to a current in a helix. The principle of a galvanometer with fixed coil and moving magnet (the galvanoscope).

An experiment to show the increase in the strength of the magnetic field when an iron core is placed in a helix carrying a current.
A study of several practical applications of the electro-magnet such as the lifting magnet, electric bell, automobile generator cut-out.

An experiment to demonstrate the motor principle, that is, to show the existence of a force acting on a wire carrying a current and lying in a magnetic field, the wire being at right angles to the direction of the lines of force.

The construction and action of a galvanometer with a fixed magnet and a moving coil. (The D'Arsonval galvanometer.)
A discussion of the development of the moving coil galvan-ometer into an instrument for measuring current. (The ammeter.)

A study of the construction of a simple motor model as an application of the motor principle and as an example of the conversion of electrical energy into kinetic energy.

The chemical effects of an electric current. (Eight periods.)

Experiments to show the liberation of oxygen and hydrogen from water acidulated with sulphuric acid, and of copper from a copper sulphate solution, and to show that the amounts liberated are proportional to the strength of intensity (symbol I) of the current and to the time.
An experiment to show electroplating with copper and a discussion of electroplating with other metals.

An experiment to determine the strength or intensity of a current using the copper voltameter. Compare with the ammeter reading.
Definition of the ampere in terms of the weight of silver deposited in one second.
Definition of the coulomb as the quantity of electricity transferred when a current of one ampere flows for one second.

Explanation of a current in a wire as a flow of electrons and in a liquid as a flow of ions.
Reference to the convention that the direction of a current is that in which the positive electricity moves.

Primary and secondary cells. (Six periods.)

The meaning of potential difference.
The meaning of the electromotive force (E.M.F.) of a cell.

An experiment to show polarization in a simple zinc-copper-sulphuric acid voltaic cell. The structure of a dry cell and a discussion of the chemical means of combating polarization.

An experiment with lead plates and dilute sulphuric acid to illustrate the principle of the storage cell.
The structure, action and care of the commercial lead storage battery. (Reference to energy transformations.)

The heat effect of an electric current. (Two periods.)

A review of the transformation of electrical energy into heat energy and the subsequent radiation of energy.
A discussion of common electrical heating appliances.

Ohm's Law. (Nine periods.)

An experiment with dry cells, high resistance, and galvanometer to show that the intensity of a current is directly proportional to the potential difference (as indicated by the number of cells) causing it.

The principle of the common type of voltmeter.

An experiment to show that for any given conductor $\frac{\text{the P.D. between its ends}}{\text{current intensity}}$ is a constant. The definition of the resistance in ohms as the value of this constant when the P.D. is in volts and the current intensity in amperes.
Statement of Ohm's Law as $V = IR$. The legal definition of the ohm.
Simple problems.

The structure and use of the resistance box and the rheostat.
Experiments to determine the resistance of a conductor by
(1) method of substitution,
(2) voltmeter-ammeter method,
(3) the use of the Wheatstone bridge.

Electromagnetic induction. (Fifteen periods.)

The story of Faraday.

Experiments to show the cause of an induced current
(1) using a bar magnet, coil and galvanometer,
(2) using an electromagnet to replace the bar magnet,
(3) by the opening and closing of a primary circuit coupled with a secondary circuit.

Experiments to show the direction of the induced E.M.F. (Lenz's Law).

Experiments to show that the magnitude of an induced E.M.F. depends on (1) the strength of the changing magnetic field, (2) the number of turns of wire cut by the magnetic field, and (3) the rate at which the lines of force are cut.

An experiment with an earth inductor to show the production of alternating currents and the principle of the generator.

A discussion and demonstration of the use of a two-segment commutator to change alternating current (A.C.) into direct current (D.C.).

The transformer: the structure, action and use of a step-up and of a step-down transformer.

The telephone.

Self-inductance. An experiment to show self-induced E.M.F. when an inductive current is interrupted.

The induction coil: its structure, operation and use (details of the function of the condenser not required).

Conductivity of a gas.
(Five periods.)

An experiment to show that a charged electroscope may be discharged by a lighted match or by a gas flame held near the knob of the electroscope.

An experiment with induction coil and either a set of simple Crookes' tubes at various pressures or a single tube capable of exhaustion by a pump, to show the conductivity of air at reduced pressure.

An experiment with a Crookes' tube containing a metal obstacle, to show that cathode rays (1) travel in straight lines, (2) excite fluorescence in the walls of the tube where they strike, and (3) are deflected by a magnet.

A simple discussion of the relation of cathode rays to electrons. Explanation of the conductivity of a gas in terms of ions and electrons.

PHYSICS, GRADES XI AND XII

OPTIONAL TOPICS

The obligatory courses can probably be taught in about three-quarters of the time available. The remainder of the time should be devoted to the study of topics selected from the optional portion of the course and to review. Teachers and pupils may have, therefore, the opportunity of spending additional time on topics in which they are particularly interested.

Musical scales.	The harmonic scale. A demonstration of the major triad, major tetrad, and major diatonic scale by means of the sonometer with a string under constant tension, using successive lengths of 90 cm., 80 cm., 72 cm., 67.5 cm., 60 cm., 54 cm., 48 cm. (Similar proportions for any desired initial length may be used.) Recognition that the ratios of the vibration frequencies of successive notes in this scale comprise only three values, namely 9/8, 10/9, 16/15. Designation of these as major tone, minor tone, semitone so that the major diatonic scale is characterized by the succession, ma tone, mi tone, s.t., ma.t., mi.t., ma.t., s.t. The equally tempered scale developed from this by making no distinction between major tone and minor tone, thus—tone, tone, semitone, tone, tone, tone, semitone. Refer to piano keyboard.
Resonance.	Experiments to illustrate resonance: (1) using tuning forks or resonance bars of the same frequency (sympathetic vibrations), (2) using tuning fork and an air column whose length can be altered. The meaning of resonance with defining statement. A mechanical illustration of the principle of resonance. A brief discussion of the human voice with reference to the vocal cords and resonance.
Interference.	One or more experiments to illustrate interference, e.g., (1) silent points near a sounding tuning fork, (2) Herschel divided tube, (3) standing waves in a vibrating string (Melde's experiment), (4) the production of beats.
The ear.	A simple study of the ear to show how its parts function in the reception and transmission of vibrations. (Technical terms not required.)
Reflection.	An experiment to show the location of images and the path of the rays to the eye, using two plane mirrors at right angles.
Refraction.	An experiment to explain apparent depth in terms of refraction at a plane surface. A demonstration of total reflection; the use of a prism as a mirror. Experiments with a diverging lens as outlined for the converging lens.
Dispersion.	Complementary colours. An examination of the flame spectra of a few common elements such as sodium, calcium, and lithium and of the vacuum-tube spectra of such gases as neon, nitrogen, and hydrogen. The principle of identification of elements by their spectra. Experiments to show the effects of the transmission, reflection, and absorption of light in producing colours; colours of natural objects and of mixtures of pigments. A comparison of the effect of the combining of the colours of light with that obtained by mixing pigments.
Electrostatics.	An investigation of the effect of rubbing together various pairs of substances and a classification of the charges as positive or negative. Applications and illustrations; references to dangerous instances. An experiment to show (1) that both positive and negative charges are induced on an uncharged, insulated conductor when a charged body is brought near it, and (2) the charging of an insulated conductor by induction.

An experiment to show that a charge placed on an insulated hollow conductor goes to the outer surface.
A brief discussion of shielding with practical application, e.g., radio tubes.
An experiment to show the escape of a charge from a point. The lightning rod.

The meaning of potential difference.

Review the meaning of work, energy and power, with emphasis on gravitational potential energy.

A demonstration with a positively charged pith ball (at the end of a short silk thread tied to a glass rod) between two charged insulated plates, one positive, the other negative, to show (1) the existence of a force acting on the pith ball anywhere in the region between the plates, (2) that the pith ball, if free to move, will go from the positive to the negative plate, and (3) that work must be done on the pith ball to move it from the negative to the positive plate.

Explanation of the meaning of potential difference as a difference in potential energy and of the movement of charges, if free to move, whenever a potential difference exists. Reference to the volt as a practical unit of potential difference.

Measurement of electrical energy and electrical power.

Proof by the method given above that the energy gained when Q coulombs move in a wire under a potential difference of V volts is $V \times Q$ units and hence, that the electrical power is $V \times I$ units.

Statement that 1 volt-ampere = 1 watt; 1 watt = $\frac{1}{746}$ horse power.
The meaning of kilowatt-hour as a unit of energy.
Simple problems relating to the cost of using electrical appliances.

X-Rays.

An experiment with a small X-ray tube and an induction coil to show (1) the discharge of an electroscope by X-rays, and (2) the passage of X-rays through such substances as wood and paper.
The origin of X-rays.

Thermionic emission of electrons.

An experiment with a diode tube (any radio tube may be used) to show that a current passes through the tube if (1) the filament is hot, and (2) the filament is negative with respect to the opposite electrode (Edison effect).
Simple discussion of the liberation of electrons from a hot metal.
Experiment, using A.C., to show the use of a radio tube in allowing current to flow in one direction only.
The meaning of rectifier and rectification.
Explanation of electrification in terms of electrons.

Photo-electricity.

An experiment to show that when light from an arc falls on a clean zinc plate connected to a negatively charged electroscope, the electroscope loses its charge. The meaning of photo-electricity; the structure and uses of a simple photo-electric cell.

CHEMISTRY, GRADE XI

NOTE:—Topics marked with an asterisk (*) are optional.

Change of state. (Eight periods.)

Recall freezing of water and melting of ice and snow. A study of liquefaction and solidification using naphthalene, sulphur, and a low melting point alloy such as Wood's Metal (65.5° C.), with particular reference to melting points.

Review the formation of steam from boiling water and the condensation of water vapour.
Recall the slow vaporization (evaporation) of water at room temperature and the more rapid vaporization when boiling.
A study of vaporization and condensation using carbon tetrachloride and mercury.
A demonstration of the vaporization of bromine in a closed tall cylinder.

A study of the sublimation of iodine and of benzoic acid.

An explanation of evaporation of liquids and solids in terms of molecular motion.

Definitions of the various changes of state.

Mechanical mixtures. (Eight periods.)

A discussion of the use of physical properties of substances for their identification.

The preparation and examination of suitable mechanical mixtures to illustrate their characteristics.
The application of distinguishing physical properties in the separation of the constituents of such mechanical mixtures as iron and sulphur, copper filings and charcoal, clay and water, kerosene and water, sugar and sand.
A study of natural mixtures such as (1) lake-shore sand, (2) milk, (3) tomato fruit, (4) granite.
Reference to industrial methods of separation.

Solutions. (Eight periods.)

Review water as a solvent.
A study of such types of solutions as solids in liquids, liquids in liquids, and gases in liquids.
A study of the factors affecting the rate of solution of solids and of gases in liquids.
A discussion of gaseous and solid solutions.
A study of unsaturated, saturated, supersaturated solutions.
A discussion of solubilities of various salts in water; solubility curves.

A comparison of the characteristics of solutions with those of mechanical mixtures.

Oxygen. (Eight periods.)

Recall the presence of oxygen in air and review the determination of the approximate percentage by volume.
A discussion of the importance and uses of oxygen.
Laboratory preparation by heating certain compounds of oxygen, such as mercuric oxide and potassium chlorate.
The action of manganese dioxide as a catalyst.
Commercial source of oxygen.
Occurrence in the free state and in combination.

The combustion in oxygen of charcoal (carbon), sulphur, phosphorus, magnesium, sodium and iron, and a study of the products (state, colour, solubility, and the effect of the solution upon litmus).
Recall the combustion of common foods.
Exothermic and endothermic reactions.
The properties of oxygen.

Kindling temperature; low-temperature oxidation; spontaneous combustion.

Elements and chemical compounds. (Thirteen periods.)

The burning of magnesium, iron or copper to form a new substance; increase of weight indicates the formation of a compound. The heating of the compound, mercuric oxide, to form elements; the mercury weighs less than the mercuric oxide; an element weighs less than the compound from which it is obtained.
List the substances previously met with (oxygen, nitrogen, iron, sulphur, mercuric oxide, iron rust, magnetic iron oxide, potassium chlorate, etc.) as elements or compounds.

A discussion of the meaning of element.

* A brief discussion of the structure of the atom, with specific reference to the hydrogen atom.

* Reference to the disintegration of radium.

The preparation of compounds (a) by direct union, e.g., copper sulphide, magnesium oxide, (b) by other methods, e.g., silver chloride, lead chromate, ammonium chloride.

Illustration of the law of conservation of mass.

Illustration of the law of constant composition, by the analysis of mercuric oxide and the synthesis of magnesium oxide.

A comparison of the characteristics of compounds with those of solutions and mechanical mixtures.

Reference to the elements in the compounds composing the human body, foods, clothing, etc.

Air and its constituents. (Two periods.)

Recall the composition and importance of air.
Reference to the rare gases and suspended particles.

Recall the interdependence of plants and animals.
A discussion of the processes tending (1) to increase, (2) to decrease the amount of carbon dioxide in air.
Reference to the carbon cycle.

Reasons for ventilation.

Recall the approximate percentage of nitrogen in the air.
Properties of nitrogen prepared from air.
A discussion of the importance and uses of nitrogen.

Water.
(Four periods.)

Recall widespread distribution of water.
Natural waters.
Test for presence of water.
Properties of chemically pure water (boiling point, freezing point, density at 4° C.).
Potable water as compared with chemically pure water.
Recall water as a solvent and the importance of this in chemistry.
Water of hydration.
Deliquescence and efflorescence.

Hydrogen.
(Seven periods.)

Preparation of hydrogen by (1) electrolysis of water, (2) the reaction of metals with water, (3) the reaction of zinc and diluted sulphuric acid.
Properties and uses of hydrogen.
Demonstration of the use of hydrogen as a reducing agent in the determination of the percentage composition by weight of water.

Acids and bases.
(Three periods.)

Recall the effect of acids on litmus.
Discover further properties of acids (dilute) using (1) other indicators, (2) action on carbonates, (3) action on suitable metals (magnesium), (4) taste as shown by soda-water, vinegar, sour milk, etc.

Discover the effect of bases on the same indicators as used for acids.

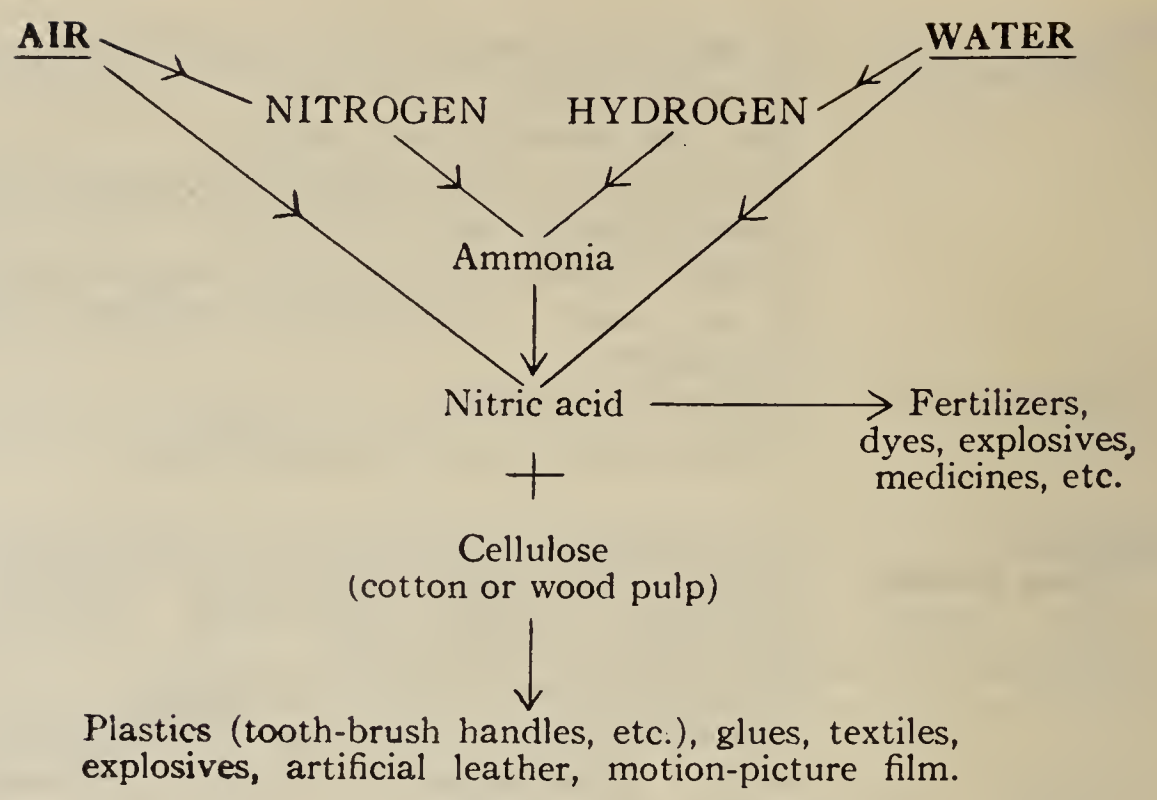
Recall the action upon litmus of the solutions of the oxides of the substances already burned in oxygen and classify as acid or basic oxides.

Test a number of substances found in the household and classify them as having acidic or basic or neutral properties.

The reaction of an acid with a base to form a salt and water (neutralization).

Chemistry at work.
(Four periods.)

This brief glance at chemistry in industry is inserted at this place to show the use in modern chemical processes of the common substances already studied and in this way to reveal to the student the relation of this science to everyday life. The reactions producing ammonia and nitric acid should be discussed without the use of formulae; the various other substances should be referred to as interesting and important derivatives of nitric acid, without involving any technical details of manufacture. The chart is intended to show the orderly production of more complex substances from simple materials, and is not to be memorized by the pupil. Where possible the discussion should be supplemented by examination of the materials.



Carbon and its compounds.
(Seven periods.)

Sources and properties of the different forms of carbon. Allotropism.
Uses of carbon in its various forms for lubrication, fuel, reduction, adsorption, etc.

Recall the properties and uses of carbon dioxide.
The preparation of carbon dioxide by the action of acids on carbonates and a detailed study of its properties.
The action of baking soda in a baking powder.
The effect of pressure on the solubility of carbon dioxide in water (Henry's Law).
The action of heat on carbonates.

The sources of carbon monoxide; dangerous and useful properties.

The preparation, properties and uses of acetylene.

Recall carbon in fats, carbohydrates, and proteins.

Fuels.
(Five periods.)

General survey of solid, liquid, and gaseous fuels.

Heat of combustion—a transformation of chemical potential energy to heat energy.
A comparison of the calorific value of various fuels.

Flame—a product of burning gas; complete and incomplete combustion.

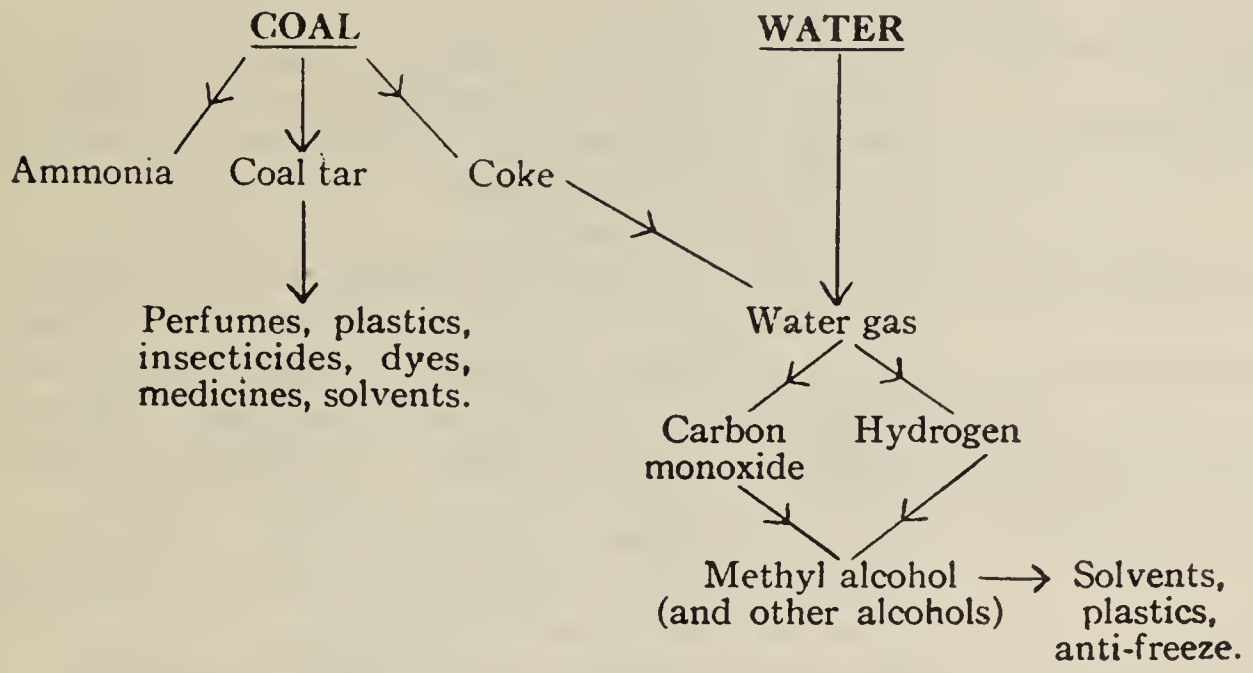
The destructive distillation of coal; reference to the important products obtained.

A demonstration of fractional distillation; reference to its application in the refining of petroleum.

Chemistry at work.
(Four periods.)

This second glance at chemistry in industry is inserted for the same purpose as the preceding one.
The various substances should be referred to as interesting and important commercial derivatives, without involving any technical details of manufacture.

The chart is not to be memorized, and where possible the discussion should be supplemented by examination of the materials.



CHEMISTRY, GRADE XII

Review.
(Ten periods.)

An experimental review of the course of Grade XI. It is suggested that the review be conducted as demonstrations by pupils.

The law of reacting weights.
(Six periods.)

Repeat the determination of the percentage composition of mercuric oxide and magnesium oxide. Recall the percentage composition of water. Calculate the weights of mercury, magnesium and hydrogen that combine with a fixed weight of oxygen (16 grams).
A consideration of a number of quantitative results from reactions involving only pure substances such as mercuric oxide, mercuric chloride, mercurous chloride, hydrogen chloride, zinc oxide, zinc chloride, chosen to show the weights of the elements as related through one another to 16 g. of oxygen.
The use of these weights to show that elements (and compounds) react in proportion to certain characteristic weights or simple multiples of them.
These weights are called reacting weights.

Symbols, formulae and equations.
(Ten periods.)

The atomic weight—a selected reacting weight.
Symbols as abbreviations for atomic weights.
Determination of the formulae for the compounds which were discussed under the law of reacting weights.
Information regarding a pure substance given by its formula (elemental composition, reacting weight).
Simple problems to find (1) the reacting weight of an element from the composition of its oxide, (2) the formula from the percentage composition, (3) the percentage composition of a compound from its formula.
The use of simple equations to represent the chemical reactions involved in experiments performed throughout the year. (Stress the fact that an equation is a record of a reaction which has actually occurred.)

Simple problems to show the use of the equation to calculate the relative weights of the substances taking part in a reaction.

NOTE:—The molecular formulae of the gases should be used in the equations and **may** be given at this stage without attempting to explain how they were determined.

Molecular formulae of gases.
(Eight periods.)

Review the compressibility of gases.
Recall the barometer and the process of measuring atmospheric pressure. Discussion of the measurement of the pressure of a gas in millimetres (or inches) of mercury, and in atmospheres. An experimental demonstration of the pressure-volume relationship in gases (Boyle's Law).

An experimental demonstration of the temperature-volume relationship in gases (Charles's Law).
Comparison of the Centigrade and Absolute scales of temperature.

Problems involving the gas laws; emphasis to be placed on principles (thermodynamic formulae not required).

A demonstration of the reacting volumes of gases, such as hydrogen and oxygen, by using the eudiometer.
A discussion of the reacting volumes of gases to develop Gay-Lussac's Law.
A statement of Avogadro's Hypothesis as an explanation of the reacting weight-volume relationships.
Information given by the molecular formulae of gases.
Simple problems on reactions involving gaseous substances.

Valency and nomenclature. (Five periods.)

Experimental determination of the valency of magnesium.
The application of valency in writing formulae.
The application of the rules of nomenclature in the naming of such binary compounds, acids, bases and salts as are met in the course.

Sulphur and its compounds. (Eight periods.)

Sources of sulphur.
The preparation of the allotropes (rhombic, monoclinic, plastic).
Properties and uses of sulphur.

Demonstration of the preparation of hydrogen sulphide and its use in the preparation of metallic sulphides. (Note the tendency of some of these sulphides, such as arsenic, antimony and zinc, to pass through filter paper.)

The laboratory preparation of sulphur dioxide.
The properties of its solution and its uses, e.g., bleaching and the production of sulphites (chemical wood pulp).

The principles of the commercial production of sulphuric acid (processes not required).
The properties and uses of sulphuric acid.

References to such sulphates as those of magnesium, copper, calcium.
Test for soluble sulphates.

Common salt. (Four periods.)

A brief discussion of the commercial recovery and industrial importance of salt.
A study of its properties.
A study of the reaction of sulphuric acid and of phosphoric acid with salt.

The laboratory preparation and properties of hydrogen chloride and of hydrochloric acid.

Sodium and potassium. (Three periods.)

The action of air on sodium and on potassium.
A review of the reaction of these metals with water.
A discussion of the properties of metals as illustrated by sodium and potassium.
A comparison of the properties of sodium hydroxide and potassium hydroxide.
The flame test for the presence of sodium and of potassium.

Chlorine, bromine and iodine (Nine periods.)

A discussion of the production of chlorine by the electrolysis of salt.
Experiments to prepare chlorine in test-tubes by the oxidation of hydrogen chloride (as hydrochloric acid).
A demonstration of the preparation and collection of chlorine and a detailed study of its properties.
An experimental study of the properties of an aqueous solution of chlorine.

A demonstration of the preparation and collection of bromine and an experimental study of its properties.
A demonstration of the relative activity of chlorine and of bromine vapour by comparison of the reactions with antimony, moist blue litmus paper, and solutions of sodium chloride, sodium bromide and sodium iodide.
Commercial sources and uses of bromine.

A demonstration of the preparation and collection of iodine.
An experimental study of the properties and uses of iodine.

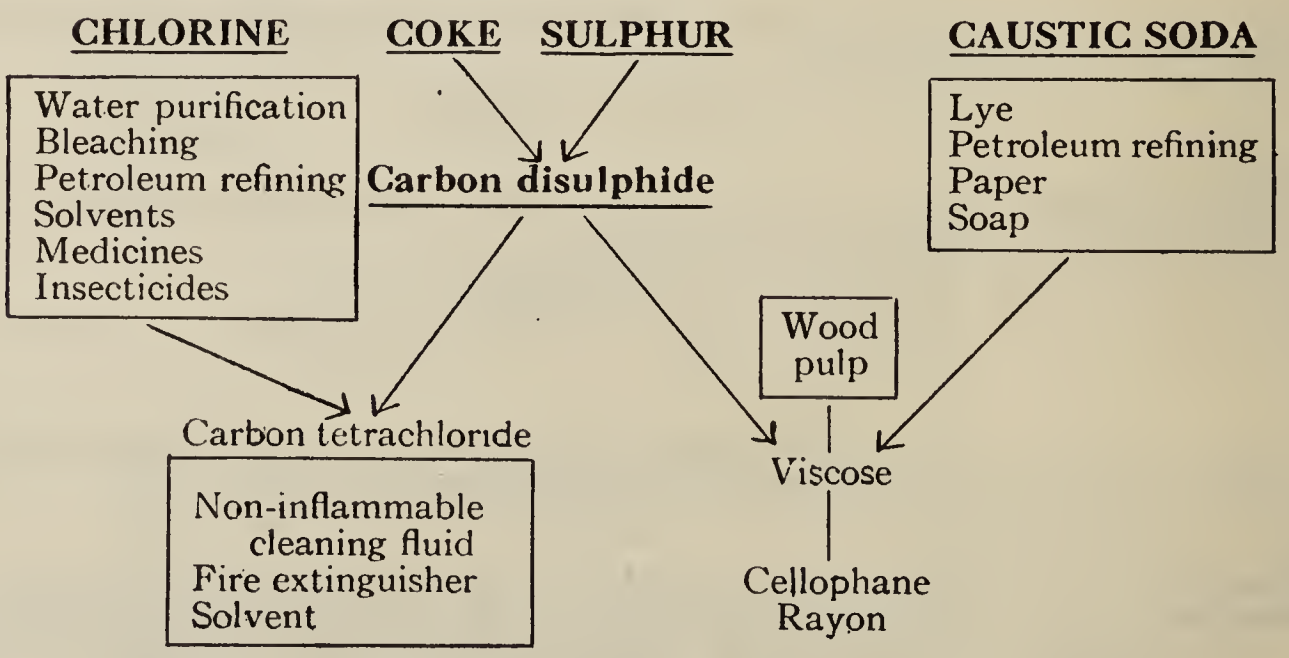
A comparison of the properties of chlorine, bromine, and iodine.

Qualitative tests to identify a chloride, a bromide, and an iodide.

Chemistry at work. (Six periods.)

In this third brief glance at chemistry in industry, the reactions producing carbon disulphide and carbon tetrachloride should be studied quantitatively. The manufacture of viscose should be examined, without involving technical details of manufacture, as a typical example of the creative combination of simple substances.

The chart is not to be memorized, and where possible the discussion should be supplemented by examination of the materials. The blocks list a few commercial uses to which brief reference should be made.



Compounds of nitrogen. (Seven periods.)

Recall the properties of nitrogen.

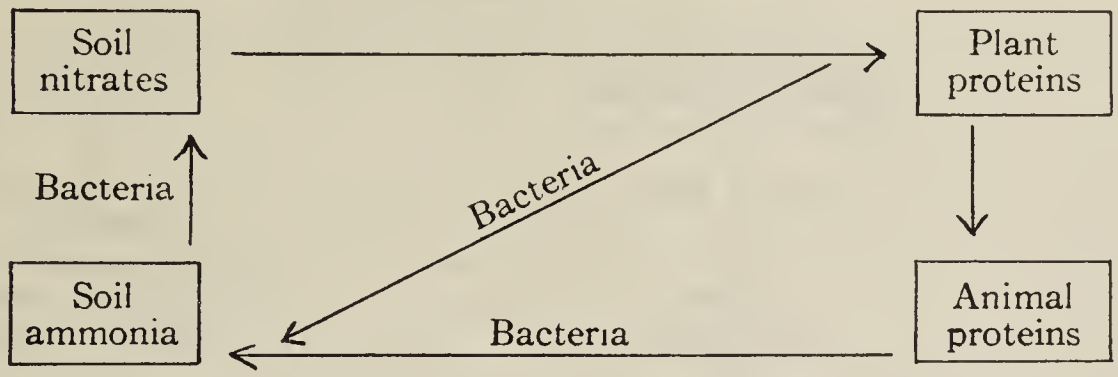
Laboratory preparation of nitric acid; its acid properties when diluted; its oxidizing action when concentrated; its uses; its toxic effect.

The properties and uses of such nitrates as those of sodium, potassium, ammonium and calcium.
The brown-ring test for nitrates.

Laboratory preparation of ammonia; its properties and uses.
Properties of a solution of ammonia.

Brief discussion of the formation and properties of such ammonium salts as ammonium chloride and ammonium sulphate.

Nitrogen and soil fertility—simple explanation of the nitrogen cycle.



*Rare gases.
(Two periods.)

* Recall the presence of rare gases in the air.
* Discuss their chemical inactivity and commercial uses.
* Commercial source of helium. Briefly discuss the history of the discovery of these gases, emphasizing the importance of precise and painstaking research.

Calcium and its compounds.
(Four periods.)

Recall the reaction of calcium with water.

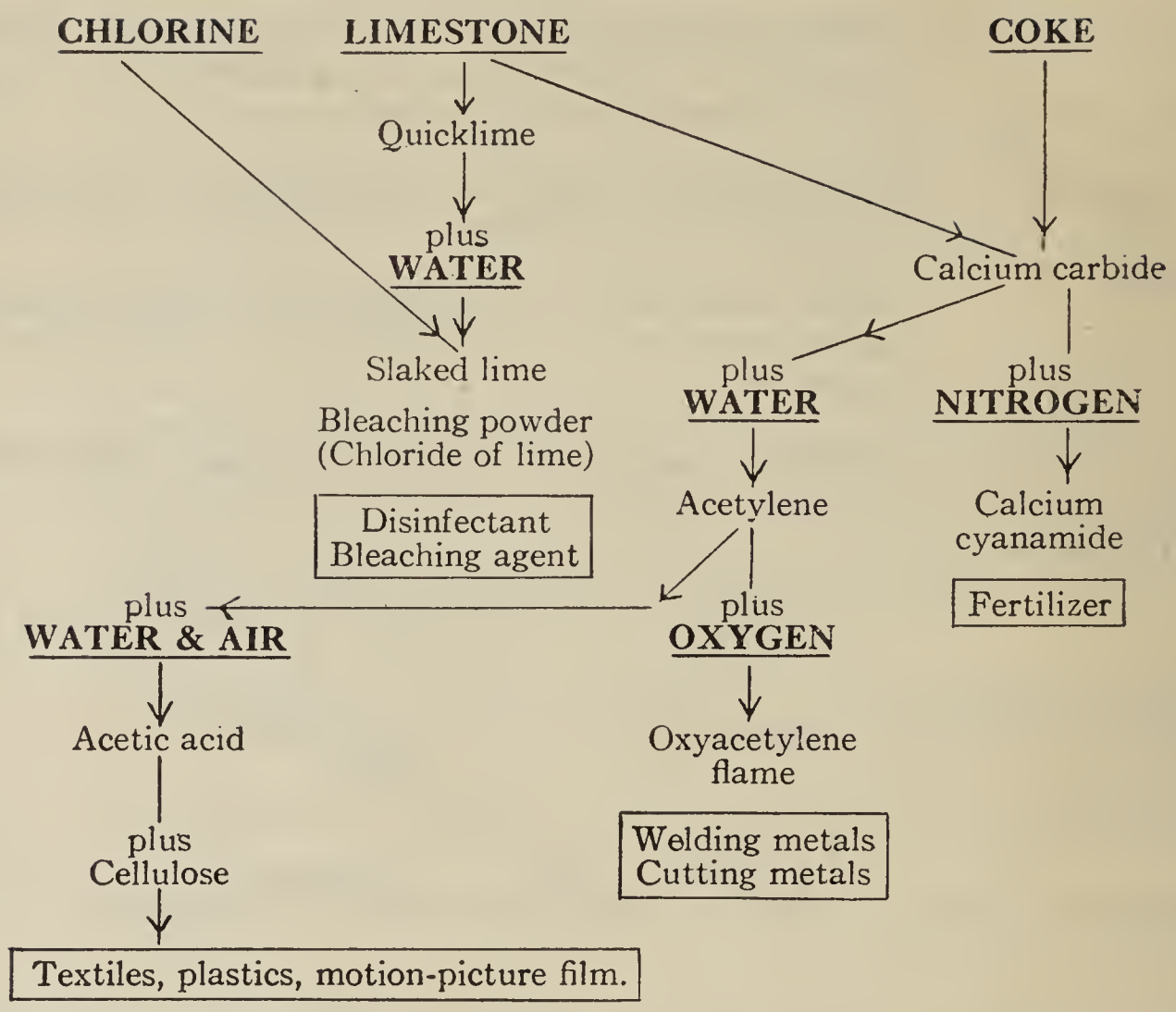
Occurrence of calcium carbonate (limestone and marble). Heating of calcium carbonate. The commercial preparation of quicklime. The slaking of quicklime.

Commercial uses of limestone, quicklime, slaked lime, gypsum, bleaching powder, calcium chloride.

Chemistry at work.
(Six periods.)

In this fourth glance at chemistry in industry, all the reactions should be studied quantitatively except those involving the preparation and use of acetic acid. The discussion should afford an opportunity to refer to the economic interdependence of industrial chemical processes. As before, the chart is not to be memorized, and the discussion should be supplemented by reference to Canadian manufacturing plants, and by examination of the materials. The blocks list a few commercial uses to which brief reference should be made.

*Optional


CHLORINE
LIMESTONE
COKE
Quicklime
plus
WATER
Calcium carbide
Slaked lime
Bleaching powder
(Chloride of lime)
Disinfectant
Bleaching agent
plus
WATER
plus
NITROGEN
Acetylene
Calcium
cyanamide
Fertilizer
plus
WATER & AIR
plus
OXYGEN
Acetic acid
Oxyacetylene
flame
plus
Cellulose
Welding metals
Cutting metals
Textiles, plastics, motion-picture film.

COURSES OF STUDY
For
Grades XI and XII
in
Collegiate Institutes, High and Continuation Schools

Schools in which Agriculture of the lower school course has been taught for at least two years, and in which it is intended to introduce Agricultural Science in the middle school at the commencement of the school year and thus qualify for the annual grants, shall make written application to the Deputy Minister before September 15th, for permission to undertake the work. This notice shall be signed by the Chairman of the Board as well as by the Principal.

The objectives outlined for Grades IX and X apply also to Agricultural Science of Grades XI and XII. These courses include the essential topics of the courses in physics and chemistry and a number of agricultural topics, the study of which will enlarge and extend the work begun in Grades IX and X. The obligatory agricultural topics as outlined should be taught in the regular school programme. As far as possible, individual interest and initiative should be encouraged and the instruction in laboratory and class room correlated with practical activities outside of school. Display of special equipment, illustrative charts and other material related to Agriculture should be arranged in the laboratory. School experimental plots, home projects and agricultural reading are optional topics which should be taken under the conditions suggested in the syllabus.

The science topics of Grades XI and XII should be treated experimentally and emphasis placed on pupil experiments throughout the course. Accuracy and precision in making observations, taking measurements and reaching conclusions are the main desiderata. Encouragement should be given to the recording of experiments by means of simple line diagrams, supplemented by very brief notes. Time should not be wasted in writing copious notes from dictation or in copying material from text or manual. It should not be demanded of the student to report in full form more than about, say, half a dozen outstanding experiments. The pupils' note-books should, however, contain a systematic record of the work covered.

AGRICULTURAL SCIENCE, PART I, GRADE XI

OUTLINE OF THE COURSE (Grade XI)

NOTE:—Topics marked with an asterisk (*) are optional.

Botany. (Ten periods.)	Parasitic fungi; the examination and recognition in different stages and methods of control of stem rust of wheat, loose smut of oats, covered smut of barley, late blight of potatoes, brown rot of stone fruits, any mildew (cherry, lilac, grape), anthracnose of bean; also the effect of these diseases on the grading and market value of farm products.
Entomology. (Ten periods.)	Life history and nature of injury and methods of control of white grub or wire worm, plum curculio or potato beetle, oyster shell scale or aphides, cabbage butterfly or tomato worm, tent caterpillar or European corn borer, warble fly or bot fly.

The effect of insect injuries on the market value of farm products.
Reference to the spray calendar and spray service.

Density and specific gravity. (Ten periods.)

Review the meaning of the term density, and show that density may be stated in various units, such as grams per cubic centimetre, grams per litre, pounds per cubic foot or cubic inch, pounds per gallon.
The meaning of the specific gravity (s.g.) of a substance.
An experiment to determine the density and the s.g. of a regular solid, e.g., a brass cylinder, by measurement of its dimensions, and by weighing. (Use of vernier calipers recommended, but not required.)
Experiments involving the application of Archimedes' Principle, to determine the s.g. (1) of the brass cylinder used above; (2) of an irregular solid, denser than water; (3) of a liquid.
An experiment to demonstrate the principle of flotation.
The hydrometer; an experiment, using the hydrometer, to determine the s.g. of brine or other liquid; or using the lactometer to determine the specific gravity of milk.

Force and motion. (Three periods.)

Experiments to illustrate the meaning of inertia and of force, and to show that force can cause a change of velocity.
Newton's First Law of Motion. The definition of force in terms of the change in velocity produced in a body. The meaning of momentum.

Mechanics. (Five periods.)

Review of levers and pulleys. Applications in farm machinery and appliances.

Light.
—Transmission. (Four periods.)

An experiment to show that a material medium is not required.
Rectilinear propagation (review).
An experiment to show the production of a pinhole image and the change in size of this image with variation in the distance of the screen or of the source of light from the pinhole. A discussion of the reason for the formation of the image.
Simple discussion of the velocity of light.

—Reflection. (Five periods.)

Experiments with plane mirror to derive the laws of reflection of light. Regular and diffuse reflection; discussion of direct and indirect lighting.
An experiment, using a single plane mirror, to show the location of images and the path of the rays to the eye.
Demonstrations, using a concave mirror, of (a) the focusing of parallel rays and (b) the production of a real image.

—Refraction. (Six periods.)

A demonstration of the refraction of light using (a) air and water and (b) air and glass. Explanation by means of waves.
An experiment to trace the path of light through a glass plate with parallel sides.
An experiment to show deviation through a prism.

—Lenses. (Four periods.)

Experiments to show the effect of a converging glass lens on parallel rays. The meaning of principal focus. The path of a ray (1) parallel to the principal axis and (2) through the centre of the lens (comparison with a ray passing obliquely through a thin glass plate). The method of locating the image and drawing ray paths to the eye as shown in converging lenses. Explanation of how the eye sees the image in a simple microscope or magnifying lens.

—Dispersion. (Three periods.)

Experiments to demonstrate the spectrum of white light, and the combination of spectrum hues to form white light. The meaning of infra-red and ultra violet.

Heat.
—Heat transfer. (Five periods.)

Review previous study of heat.

An experiment to show the comparative heat conductivities of different solids.
Experiments to compare the radiation and absorption by dull, dark, and light polished surfaces.

The expansion of solids. An experiment to show the unequal expansion of metals. The thermostat as illustrated in the incubator.

—Heat measurements. (Ten periods.)

Calorimeter experiments to determine (1) the specific heat of a metal, (2) the heat of fusion of ice.

Landscaping. (Five periods.)

Recall making and care of a lawn; a suitable lawn seed mixture.
Formal and natural landscaping plans. The location of walks or paths, the use of curves and open spaces, relation of plantings of different heights.
Planting material; annual, biennial and perennial flowering plants, and shrubs suitable for different locations and for the best seasonal display. Planting plans for home and school gardens.

* Co-operation with local Horticultural Society in pupils' projects.

*Light.
—Practical applications. (Three periods.)

The camera.
The human eye; the function of its parts in the production of an image; recall iris reflex; the action of the lens in focusing the image (accommodation); comparison with the camera. (Technical terms are not required.)

*Sound. (Ten periods.)

Experiments to show that sound has its origin in a vibrating source.
The meaning of amplitude, period, and frequency as applied to vibratory motion.
The characteristics of sounds:

(1) Intensity; its dependence on the amplitude of vibration and the distance from the source (qualitative treatment only).
(2) Pitch; a demonstration of pitch using the Savart toothed wheel or the siren. The difference between tone and noise.

(3) Quality or timbre; a demonstration of differences in quality using tuning-fork, sonometer, organ pipe, etc.

An experiment to show that a material medium is necessary for the propagation of sound.

A quantitative experiment to show that the frequency of a stretched string varies inversely as the length.

A qualitative experiment to show that the frequency depends on the tension.

The interrelation of velocity, wave length and frequency.

A brief discussion of the reflection of sound and some of its applications.

A discussion of the measurements of the speed of sound by means of echoes or by direct methods.

*Home projects.

Under the supervision of the teacher, suitable home projects, preferably of an economic value, should be undertaken by selected pupils of the middle school. In lower school, the type of home project which can be continued into Grades XI and XII should be encouraged. In many cases, such projects may be associated with the local Junior Club programme.

The following suggested projects are suitable for this type of treatment:

(1) Home grounds beautification.
(2) The improvement of the poultry flock by introduction of egg-laying strains and keeping of records.
(3) Improvement of the dairy herd by (1) starting with a pure-bred calf or (2) by keeping records and selection.
(4) The building up of an apiary.
(5) Permanent pasture improvement.
(6) Improvement of crops by plant and seed selection.
(7) Growing of plots of recommended varieties of potatoes, pasture grasses, or grains from certified seed.
(8) Soil improvement by crop rotation and fertilizer treatment over a period of years.
(9) In fruit-growing areas, the introduction of approved varieties by grafting and planting.

*Gardening.

Elementary gardening practice in planting and care of vegetables and flowers has been covered in Grades IX and X.

Gardening activities **if continued in middle school** should be taken with Grade XI pupils, and must be of a definite practical nature such as a school-ground improvement programme, planting and care of beds of perennial flowers or shrubs, the making of a lawn or the conducting of experimental plots with varieties of grasses, grains, potatoes or other crops with or without fertilizers on plots 1/100 of an acre or 436 sq. feet in area. Garden plots for the middle school should contain at least four such areas.

*Agricultural reading.

In the average middle school class and particularly in the smaller schools, there are a number of boys who come from

farm homes and who, after leaving school, are likely to engage in farming. These pupils may have developed an interest in certain agricultural topics and would benefit from more information on the subject than has been offered in the class room study. The teacher should try to assist such pupils by providing a suitable list of references for reading and study from books, bulletins and magazines which are in the library. In the case of pupils who are not taking all subjects of the middle school course, at least a part of the free periods should be given to such reading and study.

AGRICULTURAL SCIENCE, PART I, GRADE XII

OUTLINE OF THE COURSE (Grade XII)

NOTE:—Topics marked with an asterisk (*) are optional.

Electrostatics. (Five periods.)

Experiments to show the electrification of ebonite rubbed with fur (or flannel) and of glass rubbed with silk (or chamois impregnated with tin amalgam).
The charging of a pith ball by contact. Conductors and non-conductors.
An experiment using the pith ball as an electroscope to show attraction and repulsion. An experiment to show that there are two kinds of electrification.
The use of conventional terms; positive and negative—to classify electric charges.
The construction and use of the goldleaf electroscope.
An experiment to show the escape of a charge from a point.
The lightning rod.

Magnetic effect of an electric current. (Fourteen periods.)

A review of elementary magnetism with a discussion of the use of lines to picture a magnetic field.
An experiment to show magnetism induced in a para-magnetic substance placed near a bar magnet.
A discussion of the difference between a temporary and a permanent magnet.

Experiments to show (1) the lines of force about a wire carrying a current and the reversal of the magnetic field with a change in the direction of the current, (2) the magnetic field due to a current in a single turn of wire, (3) the magnetic field due to a current in a helix. The principle of a galvanometer with fixed coil and moving magnet (the galvanoscope).
An experiment to show the increase in the strength of the magnetic field when an iron core is placed in a helix carrying a current.
A study of several practical applications of the electro-magnet such as lifting magnet, electric bell, automobile generator cut-out.

An experiment to demonstrate the motor principle, that is, to show the existence of a force acting on a wire carrying a current and lying in a magnetic field, the wire being at right angles to the direction of the lines of force.

The construction and action of a galvanometer with a fixed magnet and a moving coil. (The D'Arsonval galvanometer.)
A discussion of the development of the moving coil galvan-ometer into an instrument for measuring current (the ammeter).

A study of the construction of a simple motor model as an application of the motor principle and as an example of the conversion of electrical energy into kinetic energy.

The chemical effects of an electric current.
(Eight periods.)

Experiments to show the liberation of oxygen and hydrogen from water acidulated with sulphuric acid, and of copper from a copper sulphate solution, and to show that the amounts liberated are proportional to the strength or intensity (symbol I) of the current and to the time.
An experiment to show electroplating with copper and a discussion of electroplating with other metals.
An experiment to determine the strength or intensity of a current using the copper voltameter. Compare with the ammeter reading.
Definition of the ampere in terms of the weight of silver deposited in one second.
Definition of the coulomb as the quantity of electricity transferred when a current of one ampere flows for one second.
Explanation of a current in a wire as a flow of electrons and in a liquid as a flow of ions.
Reference to the convention that the direction of a current is that in which the positive electricity moves.

Primary and secondary cells.
(Six periods.)

The meaning of potential difference.
The meaning of the electromotive force (E.M.F.) of a cell.
An experiment to show polarization in a simple zinc-copper-sulphuric acid voltaic cell. The structure of a dry cell and a discussion of the chemical means of combating polarization.
An experiment with lead plates and dilute sulphuric acid to illustrate the principle of the storage cell.
The structure, action and care of the commercial lead storage battery. (Reference to energy transformations.)

The heat effect of an electric current.
(Two periods.)

A review of the transformation of electrical energy into heat energy and the subsequent radiation of energy.
A discussion of common electrical heating appliances.

Ohm's Law.
(Two periods.)

An experiment with dry cells, high resistance, and galvanometer to show that the intensity of a current is directly proportional to the potential difference (as indicated by the number of cells) causing it. Statement and explanation of Ohm's Law. $V = IR$.
The principle of the common type of voltmeter.

Electromagnetic induction.
(Fifteen periods.)

The story of Faraday.

Experiments to show the cause of an induced current
(1) using a bar magnet, coil and galvanometer,
(2) using an electromagnet to replace the bar magnet,
(3) by the opening and closing of a primary circuit coupled with a secondary circuit.

Experiments to show the direction of the induced E.M.F. (Lenz's Law).
Experiments to show that the magnitude of an induced E.M.F. depends on (1) the strength of the changing magnetic field, (2) the number of turns of wire cut by the magnetic field, and (3) the rate at which the lines of force are cut.
An experiment with an earth inductor to show the production of alternating currents and the principle of the generator.

A discussion and demonstration of the use of a two-segment commutator to change alternating current (A.C.) into direct current (D.C.).

The transformer: the structure, action and use of a step-up and of a step-down transformer.

The telephone.

Self-inductance. An experiment to show self-induced E.M.F. when an inductive current is interrupted.

The induction coil: its structure, operation and use (details of the function of the condenser not required).

Field crops.
(Four periods.)

* History of crop improvement with special reference to O.A.C. 21, barley, marquis wheat, O.A.C. 72, oats, etc. (Special emphasis should be given to crops grown in the local area.)
* Kinds of crops, common types of farming, with special reference to the distribution and economic value of crops in the local area.
* Crop distribution in Ontario.

(Eight periods.)

A discussion of the meaning of crop rotation with examples from farms in the local area; importance and value; surveys of crop rotations.

Identification of weed seeds in grains such as wheat, oats and barley, in timothy and in clover or alfalfa (at least ten weed seeds to be identified). The importance of pure seed in relation to weed control.
Examination of a sample of grain to show the value of cleaning seed.
Germination tests.

Use of bulletins and literature in the discussion of new varieties (sources of information and their use).

Live Stock.
(Ten periods.)

Review of principle types and breeds of cattle, draught horses and swine with emphasis on the distinguishing characteristics and importance of each.
Principles of judging and improvement of breeds.
Chief market cuts of meat; grades of meat.

* Visits to local farms to study methods of stabling and care of cattle.

OR

Fruit growing.
(Ten periods.)

Orchard management: planning and planting the orchard; pruning, grafting, spraying, cultivating, fertilizing; use of cover crops.
Orchard fruits: late and early varieties, time of marketing; length of life of trees and age of bearing.
Harvesting, packing and marketing; grading and types of packing for two different kinds of fruits of the locality; cold storage and natural storage.
Planting, care and marketing of strawberries and raspberries; recommended varieties.

* Visits to fruit farms and packing houses to study methods employed there.

AGRICULTURAL SCIENCE, PART II, GRADE XI

OUTLINE OF THE COURSE (Grade XI)

NOTE:—Topics marked with an asterisk (*) are optional.

Change of state. (Six periods.)

Recall freezing of water and melting of ice and snow. A study of liquefaction and solidification using naphthalene, or sulphur and a low-melting-point alloy such as Wood's Metal (65.5° C.), with particular reference to melting points.

Review the formation of steam from boiling water and the condensation of water vapour.
Recall the slow vaporization (evaporation) of water at room temperature and the more rapid vaporization when boiling.
A study of vaporization and condensation using carbon tetrachloride and mercury.

A study of the sublimation of iodine or of benzoic acid.
An explanation of evaporation of liquids and solids in terms of molecular motion.

Definitions of the various changes of state.

Mechanical mixtures. (Eight periods.)

A discussion of the use of physical properties of substances for their identification.

The preparation and examination of suitable mechanical mixtures to illustrate their characteristics.
The application of distinguishing physical properties in the separation of the constituents of such mechanical mixtures as iron and sulphur, copper filings and charcoal, clay and water, kerosene and water, sugar and sand. Recall separation of samples of soils.
A study of natural mixtures such as (1) lake-shore sand, (2) milk, (3) tomato juice, (4) granite.
Reference to industrial methods of separation, including the cream separator.

Solutions. (Eight periods.)

Review water as a solvent.
A study of such types of solutions as solids in liquids, liquids in liquids, and gases in liquids.
A study of the factors affecting the rate of solution of solids and of gases in liquids.
A discussion of gaseous and solid solutions.
A study of unsaturated, saturated, supersaturated solutions.
A discussion of solubilities of various salts in water; solubility curves.

A comparison of the characteristics of solutions with those of mechanical mixtures.

Recall soil water as a solution.

Oxygen. (Eight periods.)

Recall the presence of oxygen in air and review the determination of the approximate percentage by volume.
Laboratory preparation by heating certain compounds of oxygen, such as mercuric oxide and potassium chlorate.
The action of manganese dioxide as a catalyst.

Occurrence of oxygen in the free state and in combination. The combustion in oxygen of charcoal (carbon), sulphur, phosphorus, magnesium, sodium and iron, and a study of the products (state, colour, solubility, and the effect of the solution upon litmus).
Recall the combustion of common foods.
Exothermic and endothermic reactions.
The properties of oxygen. Importance and uses of oxygen.

Kindling temperature; low-temperature oxidation; spontaneous combustion.

Elements and chemical compounds. (Thirteen periods.)

The burning of magnesium, iron or copper to form a new substance; increase of weight indicates the formation of a compound. The heating of the compound, mercuric oxide, to form elements; the mercury weighs less than the mercuric oxide; an element weighs less than the compound from which it is obtained.
List the substances previously met with (oxygen, nitrogen, iron, sulphur, mercuric oxide, iron rust, magnetic iron oxide, potassium chlorate, etc.) as elements or compounds.

A discussion of the meaning of element.

* A brief discussion of the structure of the atom with specific reference to the hydrogen atom.
* Reference to the disintegration of radium.

The preparation of compounds (a) by direct union, e.g., copper sulphide, magnesium oxide, (b) by other methods, e.g., silver chloride, lead chromate, ammonium chloride.

Illustration of the law of conservation of mass.

Illustration of the law of constant composition by the analysis of mercuric oxide and the synthesis of magnesium oxide.

A comparison of the characteristics of compounds with those of solutions and mechanical mixtures.

Reference to the elements in the compounds composing the human body, foods, clothing, etc.

Reference to elements most important for plant growth obtained from air, water and soil.

Air and its constituents. (Two periods.)

Recall the composition and importance of air.
Reference to the rare gases and suspended particles.
Recall the interdependence of plants and animals.
A discussion of the processes tending (1) to increase, (2) to decrease the amount of carbon dioxide in air.
Reference to the carbon cycle.

Reasons for ventilation. Applications in farm buildings.

Recall the approximate percentage of nitrogen in the air.
Properties of nitrogen prepared from air.
A discussion of the importance and uses of nitrogen.

Water.
(Four periods.)

Recall widespread distribution of water.
Natural waters.
Test for presence of water.
Properties of chemically pure water (boiling point, freezing point, density at 4° C.).
Potable water as compared with chemically pure water.
Recall water as a solvent and the importance of this in chemistry.
Solvent action of water in relation to weathering of soils, availability of nutrients and losses by leaching.
Water of hydration.
Deliquescence and efflorescence.

Hydrogen.
(Five periods.)

Preparation of hydrogen by (1) electrolysis of water, (2) the reaction of metals with water, (3) the reaction of zinc and diluted sulphuric acid.
Properties and uses of hydrogen. Reference to the use of hydrogen as a reducing agent.

Acids and bases.
(Three periods.)

Recall the effect of acids on litmus.
Discover further properties of acids (dilute), using (1) other indicators, (2) action on carbonates, (3) action on suitable metals (magnesium), (4) taste, as shown by soda water, vinegar, sour milk, etc.

Discover the effect of bases on the same indicators as used for acids.

Recall the action upon litmus of the solutions of the oxides of the substances already burned in oxygen and classify as acid or basic oxides.

Test a number of substances found in the household and on the farm (spray materials and fertilizers) and classify them as having acidic or basic or neutral properties (home activity).

Recall acidity and alkalinity of soils.

Carbon and its compounds.
(Eight periods.)

Sources and properties of the different forms of carbon.
Allotropism.
Uses of carbon in its various forms for lubrication, fuel, reduction, adsorption, etc.
Recall the properties and uses of carbon dioxide.
The preparation of carbon dioxide by the action of acids on carbonates and a detailed study of its properties.
The action of baking soda in a baking powder.
The effect of pressure on the solubility of carbon dioxide in water (Henry's Law).
The action of heat on carbonates.

The sources of carbon monoxide; dangerous and useful properties.

Recall carbon in fats, carbohydrates and proteins.

Recall source of carbon in plants.

Agricultural Science, Part II, Grade XI

Fuels.
(Three periods.)

General survey of solid, liquid and gaseous fuels.

Heat of combustion; a transformation of chemical potential energy to heat energy.

Flame; a product of burning gas, complete and incomplete combustion.

Poultry.
(Ten periods.)

The structure of the egg, candling and grading of eggs, methods of preserving eggs; food value of eggs; culling poultry for egg production. The meaning of the term "dressed" fowl; methods of finishing, killing and plucking; marketing eggs and dressed poultry.

The essentials of poultry-house construction to provide proper lighting, ventilation, dryness and freedom from draughts; feeding for egg production.

* Examination of eggs broken open every one or two days during incubation to observe the stages in the development of the embryo.

Dairying.
(Eight periods.)

The principle of the Babcock test; the use of this test in determining the percentage of fat in cream and skim milk.

Butter-making; operation and care of the cream separator; washing, sterilization and care of dairy utensils; care of cream on the farm; making butter with a laboratory churn.

Experiment to determine the percentage of water in a sample of butter; sale of butter by grade.

Distribution and importance of the dairy industry in Ontario; commercial milk products and their importance.

AGRICULTURAL SCIENCE, PART II, GRADE XII

OUTLINE OF THE COURSE (Grade XII)

Review.
(Eight periods.)

A review of the course of Grade XI.

The law of reacting weights.
(Four periods.)

The recall of the percentage composition of mercuric oxide, magnesium oxide and water; the calculation of the weights of mercury, magnesium and hydrogen that combine with a fixed weight of oxygen (16 grams).
The consideration of a number of quantitative results from reactions involving only pure substances such as mercuric oxide, mercuric chloride, mercurous chloride, hydrogen chloride, zinc oxide, zinc chloride, chosen to show the weights of the elements as related through one another to 16 grams of oxygen.
The use of these weights to show that elements (and compounds) react in proportion to certain characteristic weights or simple multiples of them.
These weights are called reacting weights.

Symbols, formulae and equations.
(Ten periods.)

The atomic weight, a selected reacting weight.
Symbols as abbreviations for atomic weights.
Determination of the formulae for the compounds which were discussed under the law of reacting weights.
Information regarding a pure substance given by its formula (elemental composition, reacting weight).
Simple problems to find (1) the reacting weight of an element from the composition of its oxide, (2) the formula from the percentage composition, (3) the percentage composition of a compound from its formula.
The use of simple equations to represent the chemical reactions involved in experiments performed throughout the year. (Stress the fact that an equation is a record of a reaction which has actually occurred.)
Simple problems to show the use of the equation to calculate the relative weights of the substances taking part in a reaction.

NOTE:—The molecular formulae of the gases should be used in the equations and **may** be given at this stage without attempting to explain how they were determined.

Molecular formulae of gases.
(Four periods.)

Review the compressibility of gases.
Recall the barometer and the process of measuring atmospheric pressure.
Discussion of the measurement of the pressure of a gas in millimetres (or inches) of mercury, and in atmospheres.

Statement of (1) pressure-volume relationship of gases (Boyle's Law), (2) temperature-volume relationship of gases (Charles's Law), and the use of these laws in simple problems. Emphasis to be placed on principles.
Statement and discussion of Gay-Lussac's Law and of Avogadro's Hypothesis.
Information given by the molecular formulae of gases.

Valency and nomenclature. (Five periods.)

Experimental determination of the valency of magnesium.
The application of valency in writing formulae.
The application of the rules of nomenclature in the naming of such binary compounds, acids, bases and salts as are met in the course.

Sulphur and its compounds. (Five periods.)

Sources of sulphur.
The preparation of the allotropes (rhombic, monoclinic, plastic).
Properties and uses of sulphur.

Demonstration of the preparation of hydrogen sulphide and its use in the preparation of metallic sulphides of silver, arsenic and antimony.

The laboratory preparation of sulphur dioxide.
The properties of its solution and its uses, e.g., bleaching and the production of sulphites (chemical wood pulp).

Properties and uses of sulphuric acid.

Reference to sulphur compounds in soils and plants and to the agricultural importance of such compounds as ammonium sulphate, copper sulphate, calcium sulphate and magnesium sulphate.
Test for soluble sulphates.

Common salt. (Four periods.)

A brief discussion of the commercial recovery and industrial importance of salt.
A study of its properties.
A study of the reaction of sulphuric acid and phosphoric acid with salt.

The laboratory preparation and properties of hydrogen chloride and of hydrochloric acid.

Sodium and potassium. (Four periods.)

The action of air on sodium and on potassium. Meaning of the term "potash" in relation to soils and fertilizers.
A review of the reaction of these metals with water.
A discussion of the properties of metals as illustrated by sodium and potassium.
A comparison of the properties of sodium hydroxide and potassium hydroxide.
The flame test for the presence of sodium and of potassium.

Importance of potassium in plant growth; solubility of compounds; lack of potassium in soils. Test for potassium in soils.

Phosphorus. (Five periods.)

Reference to yellow and red forms, phosphorus pentoxide and phosphoric acid; meaning of the term "phosphoric acid" as applied to soils and fertilizers. Forms of calcium phosphate and their relative solubility; importance of phosphorus to plant growth and loss from the soil; compounds which supply phosphorus. Test for phosphates in soils.

Chlorine, bromine and iodine. (Six periods.)

Experiments to prepare chlorine in test tubes by the oxidation of hydrogen chloride (as hydrochloric acid). Reference to bromine.
A demonstration of the preparation and collection of chlorine and a detailed study of its properties.
An experimental study of the properties of an aqueous solution of chlorine.

A demonstration of the preparation and collection of iodine.
An experimental study of the properties and uses of iodine.
A comparison of the properties of chlorine and iodine.
Qualitative tests to identify a chloride and an iodide.

Compounds of nitrogen. (Five periods.)

Recall the properties of nitrogen.

Laboratory preparation of nitric acid; its acid properties when diluted; its oxidizing action when concentrated; its uses; its toxic effect.
The properties and uses of such nitrates as those of sodium, potassium, ammonium and calcium.
The brown ring test for nitrates.

Laboratory preparation of ammonia, its properties and uses.
Properties of a solution of ammonia.
Brief discussion of the formation and properties of such ammonium salts as ammonium chloride and ammonium sulphate.

Importance of nitrogen to plants; loss of nitrogen compounds from the soil and replacement by nature.
Test for nitrates in soils.

Calcium and its compounds. (Four periods.)

Recall the reaction of calcium with water.
Occurrence of calcium carbonate (limestone and marble).
Heating of calcium carbonate. The commercial preparation of quicklime. The slaking of quicklime.
Commercial uses of limestone, quicklime, slaked lime, gypsum, bleaching powder, calcium chloride.
Test for calcium in soils.

Soils. (Eight periods.)

Soil profile: examination of a soil profile in the field; distinction between surface soil and subsoil; discussion of character of subsoil in relation to drainage, moisture retention and root penetration. Plant nutrients in soils. The essential nutrients for plant growth obtained from the soil. A brief discussion of plant nutrients in soil with special attention to those required by plants in larger amounts and which may commonly be deficient; functions of the four major nutrients in plant growth. Comparison of the amounts of nitrogen, phosphorus, potassium and calcium removed by crops and lost by leaching from the soil.

Organic matter and nitrogen; the importance of organic matter (humus) maintenance in relation to physical condition, moisture-holding capacity and supply of nitrogen in the soil.

Organic matter the storehouse of soil nitrogen: nitrogen made available by decomposition, ammonification and

nitrification; addition of nitrogen by nitrogen fixation by legume bacteria; free fixation by azotobacter and by rainfall (nitrogen cycle).

The value of crop residues, farm manures and green manures for supplying organic matter in the soil.

Manure and commercial fertilizers. (Fifteen periods.)

Review the meaning of the terms "nitrogen," "phosphoric acid" and "potash" as used in reference to manure and commercial fertilizers; the importance of farm manure as a fertilizer; losses in storage and methods of conserving plant nutrients in manure.

Examination of the following materials used alone or in mixtures to supply nitrogen, phosphoric acid and potash: nitrate of soda, sulphate of ammonia, ammo-phos, calcium cyanamid, blood meal; superphosphate, steamed bone meal; muriate of potash, sulphate of potash.

Tests to show the relative solubility in water and the presence of nitrate, ammonium or organic nitrogen in the nitrogen fertilizers; of water soluble phosphate in superphosphate or steamed bone meal; and of water soluble potash in muriate of potash and sulphate of potash.

The Fertilizers Act, Sections 1, 2, 3, 4, 5 and 9.

A review of the principles of soil fertility maintenance.